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FEDERAL AID IN FISH RESTORATION
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Population Studies of Game Fish and Evaluation of Managed Lakes in the Upper Cook Inlet Drainage

G-III-D Alan C. Havens

ALASKA DEPARTMENT OF FISH AND GAME
Ronald O. Skoog, Commissioner
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STATE OF ALASKA

Jay S. Hammond, Governor

Annual Performance Report for

LAKE AND STREAM INVESTIGATIONS

by

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ALASKA DEPARTMENT OF FISH AND GAME

Ronald O. Skoog, Commissioner

DIVISION OF SPORT FISH

E. Richard Logan, Director

RESEARCH PROJECT SEGMENT

State: ALASKA Name: Sport Fish Investigations of Alaska

Project No.: F-9-14

Study No.: G-III Study Title: LAKE AND STREAM INVESTIGATIONS

Job No.: G-III-D Job Title: Population Studies of Game Fish and Evaluation of Managed Lakes in the Upper Cook Inlet Drainage

Cooperator: Alan C. Havens

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ABSTRACT

This research project was initiated in 1973 to provide information for the development of improved stocking practices through identification and analysis of various limnological parameters and their effects on stocked fish populations. Major emphasis in recent years has been to determine survival and growth of rainbow trout in lakes of known limnological characteristics.

An investigation of two stocking sizes of Swanson strain rainbow trout, Salmo gairdneri Richardson, in six Matanuska-Susitna Valley lakes indicates survival to Age I+ was nearly equal for adipose-clipped fingerling at 350 per pound fingerling when both groups were stocked in waters containing threespine stickleback, Gasterosteus aculeatus Linnaeus.

Growth and relative survival of stocked Swanson strain rainbow trout in rehabilitated Kepler-Bradley Lake appeared greater than for similar trout plants in stickleback-infested Matanuska and Knik Lakes. From time of introduction to Age I+, the stomachs of trout sampled in Kepler-Bradley Lake contained mainly zooplankton. In Matanuska and Knik Lakes, however, while zooplankton was the predominant food item in stickleback stomachs, rainbow trout displayed a more varied food selection with benthic invertebrates the main food item.

Population estimates were performed in October 1980 and May 1981 in Johnson and Long Lakes to determine initial and over-winter survival of Swanson strain rainbow trout fingerling stocked in August 1980. Subsequent to initial mortalities immediately after stocking, no loss of fish was indicated in rehabilitated Johnson Lake between October and the following May

but it appeared stickleback infested Long Lake experienced a loss of approximately 2,600 trout, 36 percent of the initial survival, during that same period.

KEY WORDS

Southcentral Alaska, rainbow trout, population estimates, fish growth, food habits, competition, limnology, productivity, habitat, capture techniques.

BACKGROUND

Alaska's lake stocking program makes an important contribution to recreational fisheries within the State, but does not always produce desired results. A high cost to the creel often occurs due to poor game fish survival which, in turn, reduces recreational fishing opportunity.

A study designed to provide information for development of improved lake stocking practices was initiated in 1973. This study has focused on selected Matanuska-Susitna Valley lakes and is based on identification and analysis of various limnological parameters and their effects on fish populations. Long range project goals are: (1) to develop a lake stocking manual with guidelines for determining optimum sizes, densities, times, species and strains of fish for various lake types to achieve maximum survival, growth and harvest potential; and (2) to develop equipment to efficiently sample stocked fish populations with minimum detriment to harvestable stocks.

The early phase of this project concentrated on detailed collection of physical and chemical data and identification and relative quantification of various planktonic and invertebrate populations in untreated lakes and in treated lakes prior to, during and after chemical rehabilitation with rotenone. Findings from the initial investigative phase indicate: (1) a morpheodaphic index (MEI, or specific conductance divided by mean depth) can give a gross measure of relative potential productivity and, in most cases, it is easier to determine than statistically comparable plankton, periphyton, chlorophyll a indicies or definitive water chemistry (Chlupach, 1977); (2) lakes chemically treated with rotenone may require between 1 and 2 years to reestablish zooplankton production and 3 years to attain invertebrate production levels of previous dominance and abundance (Chlupach, 1977); and (3) a chemical test for the determination of rotenone in water (Post, 1955) can give a reasonably accurate measurement of residual rotenone concentrations at or below 0.2 ppm (Kalb, 1974).

The second phase of this project has concentrated on determining stocked game fish survival and growth in lakes of known limnological characteristics, some of which contain competitor or predator species, or both. Findings from this research segment show: (1) growth of rainbow trout may be restricted in waters infested with stickleback (Kalb, 1975); (2) rainbow trout survival appears to be greater in waters where stickleback have been eradicated than in waters where these competitors are present, although in a stickleback environment, fish survival increases when relatively larger fish are stocked at lower densities (Chlupach, 1978); (3) coho salmon,

Oncorhynchus kisutch (Walbaum), in landlocked lakes exhibit significantly greater survival than do domestic rainbow trout strains (Chlupach, 1978); (4) the most critical period affecting the survival of rainbow trout fingerling stocked in lakes may be within a month following introduction and possibly within the first several hours or days following release (Havens, 1980); (5) rainbow trout fingerling placed in a holding pen for 24 hours before release in a rehabilitated lake and a lake containing stickleback appeared to have a 4% and 6%, respectively, higher survival than did fingerling released directly from a hatchery transport tank (Havens, 1981); and (6) two to over six times more rainbow trout fry stocked at 1,000 fish per pound may be needed than 350/lb rainbow fingerling to achieve equal survivals of Swanson strain rainbow trout to catchable size at Age I+ depending on lake productivity and the occurrence of predator or competitor species, or both (Havens, 1981).

While collecting survival and growth information in stocked lakes, various capture techniques and sampling gear have been utilized for experimentation purposes. Data from this research indicate: (1) minnow traps painted a camouflaged green and brown appear to catch more rainbow trout fingerling per trap hour than do unpainted silver (galvanized wire) traps when fished in stocked lakes during ice-free seasons (Havens, 1979); (2) fyke nets fished in late summer and fall, when water temperatures are at or below 10 10°C (50°F), are capable of catching sufficient numbers of Age I+ rainbow trout for marking purposes when performing population estimates (Havens, 1980); (3) fyke nets with 3/16 inch square mesh capture fish in size ranges comparable to those caught by 1/4 inch mesh minnow traps, the catch per unit of effort can greatly exceed that of minnow traps and when fished in conjunction with minnow traps are an effective means for capturing rainbow trout fingerling for both the mark and recapture portions of a population estimate (Havens, 1981); and (4) monofilament gill nets which include a 5/8 inch mesh panel in addition to 1/2, 3/4, 1, 1-1/2 and 2-inch mesh panels may help to reduce error in recording growth and abundance for populations of rainbow trout with a mean length of less than 180 mm as is often found in lakes with low relative productivity or that contain stickleback (Havens, 1981).

Another facet of the investigation was the selection of a native Alaskan strain of rainbow trout from the Swanson River on the Kenai Peninsula as brood stock for Alaska's lake stocking program. Six years of research, from 1974 to 1979, indicated the Swanson trout had a significantly greater survival, under all natural lake conditions examined, than did an Alaskan strain of rainbow trout from Bristol Bay or the domestic Alaska-Ennis (Montana) or Winthrop (Washington) strains which had supported Alaska's rainbow stocking program for many years (Havens, 1980).

Subsequent to the selection of Swanson strain rainbow trout as brood stock for Alaska's lake stocking program, as part of the long range goals of this lake study project, baseline data on the growth and survival of the Swanson strain in all types of stocked lakes are being collected. A larger, more modern rainbow trout hatchery being constructed in the Anchorage area should have the capability to hold and rear several brood stock strains. Candidate brood strains can be examined for hatcheries suitability,then tested against the Swanson strain in field performance in the search for

rainbow trout strains that can provide the best possible survival, growth and harvest potential in all lake types when stocked as fry or fingerling.

Table 1 lists all species mentioned in this report. Table 2 gives the morpheodaphic index for selected Matanuska-Susitna Valley lakes and Figure 1 is a map showing the study area.

RECOMMENDATIONS

1. Survival, growth and biomass of Swanson strain rainbow trout should be determined in Johnson, Junction, Knik, Matanuska, Ravine, Reed, Sliver, Tigger and Walby Lakes.

2. Population estimates should be obtained for Swanson strain rainbow trout fingerling stocked by various release methods in Johnson, Junction, Matanuska and Sliver Lakes.

3. Investigation into trout habitat preference and rearing areas in Johnson Lake should be continued.

4. Techniques and equipment necessary to determine survival, growth and biomass of stocked game fishes should be developed.

5. Costs to the creel should be obtained for fish stocked in study lakes when harvest estimates are available.

OBJECTIVES

1. To determine survival, growth and total yield of stocked game fishes in landlocked lakes of the area.

2. To determine limnological conditions which affect survival and growth of game fishes stocked in study lakes.

3. To provide recommendations for the management of stocked lakes and to direct the course of future studies.

TECHNIQUES USED

Rainbow trout populations in Johnson, Long and Junction Lakes were determined by Chapman's modification of the Peterson estimator or by Chapman's modification of the Schnabel multiple census estimate of population size (Ricker, 1975).

In each lake, fish were captured for marking purposes with minnow traps or fyke nets or both. Minnow traps used to capture newly stocked fingerlings were semi-collapsible and 17-1/2 inches in length with 1/8 inch square wire mesh painted green and brown and baited with salmon eggs. The traps used to sample populations with larger fingerling were either the 1/8 inch traps or 1/4 inch minnow traps. Fyke nets, baited with salmon eggs, were two sizes of a similar design: (1) large mesh fyke nets 12 feet long,

Table 1. List of Common Names, Scientific Names and Abbreviations.

Common Name	Scientific Name and Author	Abbreviation
Rainbow trout	*Salmo gairdneri* Richardson	RT
Coho salmon	*Oncorhynchus kisutch* (Walbaum)	SS
Threespine stickleback	*Gasterosteus aculeatus* Linnaeus	TS
Arctic grayling	*Thymallus arcticus* (Pallas)	GR

Table 2. Morphoedaphic Index Values for Selected Lakes in the Matanuska-Susitna Valleys (Watsjold, 1976).

Lake	MEI*	Lake	MEI*
Lucille	23.5	Memory	5.3
Harriet	21.3	Reed	4.9
Canoe	18.1	Meirs	3.4
Falk	16.7	Rocky	3.1
Echo	15.9	Christiansen	1.8
Seymour	14.6	Benka	1.3
Finger	13.3	Loon	1.3
Junction	13.2	South Rolly	1.2
Kepler	11.6	Big No Luck	1.1
Irene	10.4	Twelve Mile	1.0
Long	9.4	Prator	0.9
Victor	9.3	Milo #1	0.7
Knik	9.1	Chicken	0.5
Matanuska	8.2	Byers	0.5
Florence	7.6	Marion	0.4
Johnson	7.4		

* MEI (morphoedaphic index) = conductance divided by mean depth. MEI gives a gross measure of relative potential productivity useful for categorizing and management purposes. MEI values above 13 are most productive, values below 3 are least productive, while values between 3 and 13 range from moderately low to moderately high in productivity (Chlupach, 1978).

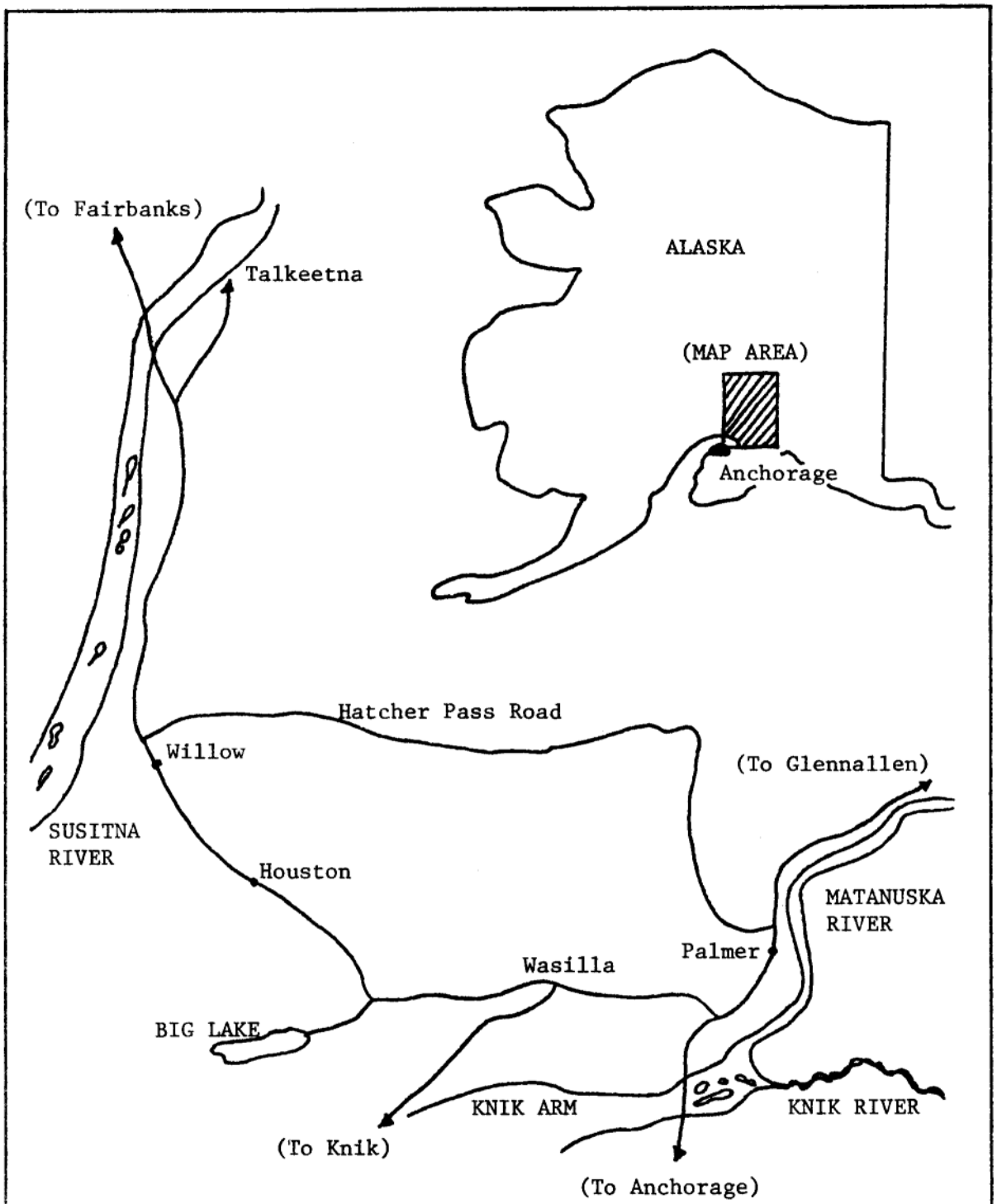

Fig. 1. Study Lake Area of Matanuska-Susitna Valleys.

40 inches in diameter, including two 4-foot x 25-foot wings (two square aluminum frames and five aluminum hoops supported the entrance and body of the fyke net), internal throats, body and wings were of 3/8 inch square mesh knotless nylon; (2) small mesh fyke nets were 9 feet in length, 30 inches in diameter and including two 3-foot x 20-foot wings, (two square aluminum frames and five aluminum hoops supported the entrance and body of the fyke net) internal throats, body and wings were of 3/16 inch square mesh knotless nylon.

Rainbow trout were later recaptured using minnow traps, fyke nets or gill nets or a combination of the three gear types. Gill nets were 120 foot x 6 foot variable mesh monofilament gill net composed of six mesh sizes, 1/2 inch, 5/8 inch, 3/4 inch, 1 inch, 1-1/2 inch and 2 inch, each in a 20-foot panel.

Catch rates and growth of rainbow trout in stocked lakes were determined by the use of variable mesh gill nets, fyke nets or minnow traps.

All catch and survival ratios for rainbow trout were adjusted for stocking densities. Fish measurements were expressed in fork lengths to the nearest millimeter and in weight to the nearest gram.

Marked Swanson strain rainbow trout stocked in study lakes in August and September 1980 and 1981 were anesthetized and fin-clipped at the hatchery and hand counted into transport tanks while unmarked fish numbers were obtained by weight sample.

All captured trout were held in a tub, oxygenated with a portable 20-pound regulated oxygen bottle and anesthetized with equal parts of MS-222 and Quinate at about 0.25 grams of anesthetic per gallon of water. Fish were then measured, enumerated and marked. Rainbow trout in Junction Lake were marked by the removal of the left ventral fin. Trout in Johnson and Long Lakes were marked with a cold brand design on the right side between the lateral line and the dorsal fin. The marking tools consisted of a raised symbol of a rectangle designed on a 1/4 inch silver tip soldered on a 3/8 inch brass rod inserted into a wooden dowel handle. The rods were cooled to -80°C by immersion in a slurry of dry ice and 100% ethanol kept in a styrofoam container. The marking rod was removed from the slurry and applied firmly and evenly on the side of the fish for approximately 2 seconds (Everest and Edmundson, 1967). The fish was then returned to the water.

FINDINGS

Effect of Stocking Size on Fish Survival

To compare survival between two stocking sizes of Swanson strain rainbow trout in various lake types, six Matanuska-Susitna Valley lakes were each stocked in 1980 with two size groups of fish; i.e., unmarked fingerling at approximately 500/lb and adipose-clipped fingerling at approximately 395/lb (Table 3). In each lake both groups of fish were planted at the same time and at nearly equal densities.

Table 3. Stocking Summary for Swanson Strain Rainbow Trout in Selected Matanuska-Susitna Valley Lakes, 1980.

Lake*	MEI	Surface Area (Acres)	Littoral** Area (Acres)	Mark***	Date Stocked	Number Stocked	Stocking Size (Fish/lb)	Stocking Density (Fish/ Surface Acre)	Stocking Density (Fish/ Littoral Acre)
Big No Luck	1.1	67.9	36.0	NM	8/19/80	2,601	510	77	145
				AD	8/19/80	2,605	398		
Junction	13.2	10.9	6.0	NM	8/18/80	1,085	499	199	362
				AD	8/18/80	1,085	391		
Marion	0.4	113.0	37.3	NM	8/20/80	5,650	500	100	303
				AD	8/20/80	5,650	395		
Ravine****	20	12.3	7.6	NM	8/19/80	1,230	500	200	324
				AD	8/19/80	1,230	409		
Sliver	22.9	7.2	5.1	NM	8/19/80	1,000	498	278	392
				AD	8/19/80	1,000	383		
"Y"	2.0	39.7	21.9	NM	8/20/80	2,745	508	138	251
				AD	8/20/80	2,750	395		

* Big No Luck, Junction and "Y" Lakes contain stickleback populations. Sliver Lake has a remnant population of grayling that were stocked in 1970. Ravine, Marions and Big No Luck Lakes each contain residual populations of stocked rainbow trout.

** Littoral area is that portion of the lake less than 15 ft deep.

*** Mark: Ad = adipose finclip; NM = unmarked.

**** Ravine Lake MEI is approximated at 20 when specific conductance is modified for abnormally high sodium ions.

Preliminary Sampling:

Havens (1981) reported sampling in October 1980 in Marion Lake, using baited minnow traps, resulted in a catch of 250 unmarked fingerling (stocking size 500/lb) and 403 adipose-clipped trout (stocking size 395/lb) for a catch ratio of 1:1.6.

Sampling in June 1981 in Ravine Lake gave a catch ratio for 500/lb to 395/lb fingerling of 1:1.7, in "Y" Lake a ratio of 1:1.8, while in Sliver Lake the ratio was 1:0.8 indicating a higher survival of the smaller unmarked trout.

Junction Lake was sampled extensively in May 1981 with minnow traps and fyke nets to evaluate survivals of the trout stocked in 1980. A population estimate at the 95% confidence level for both stocking groups is as follows:

Stocking Size	Population Estimate	Survival	95% Confidence Level	
			Estimate	Survival
499/lb	381	35%	349-413	32%-38%
391/lb	541	50%	510-573	47%-53%

The population estimate in Junction Lake gives a survival ratio of the 499/lb trout to the 391/lb fish as 1:1.4.

Survival Ratios at Age I+:

All six lakes were gill-netted and fyke-netted within an 8-day period in October 1981 to obtain a relative survival ratio to catchable size between the two stocking sizes (Table 4). The ratio of the unmarked fingerling (500/lb) to the adipose-marked trout (395/lb) from the net catches ranged from 1:0.7 to 1:2.1.

In two lakes, Sliver and Ravine, the ratios indicated a higher survival of the smaller unmarked fish stocked at approximately 500/lb. Sliver Lake preliminary sampling in June 1981 gave a 500/lb to 395/lb ratio of 1:0.8 which was close to the ratio of 1:0.9 indicated by net catches in October 1981. Sliver Lake had no stickleback population, had only a remnant population of Arctic grayling, Thymallus arcticus (Pallas), stocked in 1970 and is of high relative fertility (MEI 22.9). There was no known fishing effort on the 1980 rainbow trout plant in Sliver Lake so the lower indicated survival of the larger marked fish may have been due to clip related stress. Ravine Lake, like Sliver Lake, has a high relative fertility (approximated at MEI 20) and has no stickleback population although it does have a residual population of stocked trout. The trout stocked in 1980 probably experienced unmeasured fishing mortality between the time of preliminary sampling in June 1981 and the sampling in October 1981. A small sample size in June and a disproportionate loss of the larger

Table 4. Sampling Results and Survival Ratios for Two Stocking Sizes of Swanson Strain Rainbow Trout in Six Matanuska-Susitna Valley Lakes, 1980 and 1981.

Lake	MEI	Stickleback Present	Date Stocked	Number Stocked	Stocking Size (Fish/lb)	Preliminary Sampling Date	Number Captured	Ratio 500/lb:395/lb	October 1981 Sampling Number Captured	October 1981 Sampling Ratio 500/lb:395/lb
Big No Luck	1.1	Yes	8/19/80	2,601	510	...	...	...	147	1 : 1.3
			8/19/80	2,605	398	...	...	...	196	
Junction	13.2	Yes	8/18/80	1,085	499	5/19/81	325	1 : 1.4	149	1 : 1.2
			8/18/80	1,085	391		462		183	
Marion	0.4	No	8/20/80	5,650	500	10/31/80	250	1 : 1.6	171	1 : 1.2
			8/20/80	5,650	395		403		210	
Ravine*	20	No	8/19/80	1,230	500	6/16/81	16	1 : 1.7	86	1 : 0.7
			8/19/80	1,230	409		27		63	
Sliver	22.9	No	8/19/80	1,000	498	6/ 3/81	74	1 : 0.8	117	1 : 0.9
			8/19/80	1,000	383		62		111	
"Y"	2.0	Yes	8/20/80	2,745	508	6/12/81	30	1 : 1.8	99	1 : 2.1
			8/20/80	2,750	395		53		209	

* Ravine Lake MEI is approximated at 20 when specific conductance is modified for abnormally high sodium ions.

adipose-clipped fish to sport fishing may have caused the difference in ratios between the two sampling periods from 1:1.7 in June to 1:0.7 in October 1981.

Both preliminary and October 1981 sampling in Marion, Junction and "Y" Lakes indicated a higher relative survival of the marked fingerling stocked at approximately 395/lb as did the sample taken in Big No Luck Lake in October 1981. Marion Lake has a very low relative fertility (MEI 0.4) and a population of rainbow trout stocked in previous years. Big No Luck Lake, relative fertility (MEI 1.1), has a stickleback population and populations of rainbow trout stocked in previous years. Junction Lake (MEI 13.2) and "Y" Lake (MEI 2.0) each have stickleback populations but neither had been stocked previously.

Growth Comparisons:

A length-weight summary from gill net catches in October 1981 is presented in Table 5. In each lake the mean length and weight of the trout stocked at 395/lb exceeds that of the fish stocked at 500/lb with the greatest difference between the mean sizes of the two stocking groups found in Junction and "Y" Lakes which contain stickleback but were not previously stocked.

Havens (1981) reported results of a 1979 experiment where two size groups of Swanson strain rainbow trout (approximately 1,000/lb and 350/lb) were each stocked at about equal densities in six Matanuska-Susitna Valley lakes. The survival ratios, 1,000/lb/:350/lb, ranged from 1:2.1 to 1:6.0 (Table 6). Johnson, Weiner, Irene and Reed Lakes, which are free of stickleback, had the closest survival ratios between the two stocking groups, while Tigger Lake, which contains stickleback, had a survival ratio of 1:5.8. The great difference in survival between the 1,000/lb and the 350/lb fish in Florence Lake, which has no stickleback, may have been attributable to predation on the smaller fish by large populations of hold-over trout. A comparison between lakes for the combined 1979 rainbow trout plant indicated total survivals of 35%, 40% and 42% in Florence, Weiner and Johnson Lakes, respectively, while stickleback infested Tigger Lake had a total survival for both stocking groups of only 8%. In each lake the smaller fish, which were stocked a month earlier, went into winter at a larger size and maintained that size advantage at least through an entire year after being stocked.

The results of the 1980 experiment between the 500/lb and 395/lb stocking sizes of Swanson strain rainbow trout fingerling indicated survival ratios, 500/lb/:/395/lb, ranged from 1:0.7 to 1:2.1. Sliver and Ravine Lakes, which have high relative fertilities and were free of stickleback, produced catch ratios indicating nearly equal survivals for both stocking groups while in the lower fertility lakes that had stickleback populations the larger fish stocked at about 395/lb appear to have better survivals. In all lakes the fingerling stocked at a larger size maintained that size advantage after a full year of lake residency.

Two size groups of Swanson strain rainbow trout (approximately 500/lb and 200/lb) have been stocked in nine Matanuska-Susitna Valley lakes (Table 7) for a 1981 experiment comparing the effect of stocking size on fish

Table 5. Length-Weight Summaries for Two Stocking Sizes of Swanson Strain Rainbow Trout in Selected Matanuska-Susitna Valley Lakes, 1981.

Lake	MEI	Date Stocked	Number Stocked	Stocking Size (Fish/lb)	Capture Date	Number Captured	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)	C.F.**
Big No Luck	1.1	8/19/80	2,601	510	10/13/81	74	159	114-207	45	16-104	1.12
		8/19/80	2,605	398	10/13/81	112	164	123-212	49	18-102	1.11
Junction	13.2	8/18/80	1,085	499	10/ 6/81	41	199	146-348	105	36-517	1.33
		8/18/80	1,085	391	10/ 6/81	48	225	151-315	162	37-448	1.42
Marion	0.4	8/20/80	5,650	500	10/ 8/81	39	181	148-262	66	34-209	1.11
		8/20/80	5,650	395	10/ 8/81	64	192	138-272	78	31-243	1.10
Ravine*	20	8/19/80	1,230	500	10/ 6/81	39	210	165-261	105	50-190	1.13
		8/19/80	1,230	409	10/ 6/81	31	221	177-272	123	62-214	1.14
Sliver	22.9	8/19/80	1,000	498	10/ 7/81	29	289	228-338	271	136-453	1.12
		8/19/80	1,000	383	10/ 7/81	34	295	240-345	293	168-420	1.14
"Y"	2.0	8/20/80	2,745	508	10/ 9/81	26	188	112-313	99	14-382	1.49
		8/20/80	2,750	395	10/ 9/81	79	209	106-308	132	14-396	1.45

* Ravine Lake MEI is approximated at 20 when specific conductance is modified for abnormally high sodium ions.

** C.F. = Condition Factor = $\frac{100,000\ W}{L^3}$

Table 6. Gill Net Results and Survival Ratios for Two Stocking Sizes of Swanson Strain Rainbow Trout in Six Matanuska-Susitna Valley Lakes, 1980.

Lake	Date Stocked	Number Stocked	Stocking Size (Fish/lb)	Gill-netting Date Captured	Gill-netting Number Captured	Gill-netting Ratio 1,000/lb:350/lb	Population Estimate Number Surviving	Population Estimate Ratio 1,000/lb:350/lb
Johnson	8/14/79	3,980	970	10/3/80	18	1:1.7	974	1:2.5
	9/10/79	3,800	362	10/3/80	29		2,288	
Florence	8/13/79	5,300	970	9/29/80	7	1:4.9	503	1:6.0
	9/ 7/79	5,900	349	9/29/80	38		3,365	
Weiner	8/14/79	2,690	970	9/29/80	3	1:8.9*	626	1:2.5*
	9/10/79	2,425	362	9/29/80	24		1,437	
Tigger	8/13/79	2.200	980	9/24/80	6	1:5.5	48	1:5.8
	9/ 7/79	2,477	349	9/24/80	37		313	
Irene	8/14/79	1,790	970	9/26/80	11	1:3.1	...	...
	9/ 7/79	1,920	349	9/26/80	37		...	...
Reed	8/14/79	1,995	970	9/26/80	10	1:2.1	...	...
	9/ 7/79	2,145	349	9/26/80	22		...	...

* The great difference between the ratios by the two methods in Weiner Lake may be due to the inefficient gill net catch of trout which ranged from 122-173 mm in length.

Table 7. Stocking Summary for Swanson Strain Rainbow Trout in Selected Matanuska-Susitna Valley Lakes, 1981.

Lake*	MEI	Surface Area (Acres)	Littoral** Area (Acres)	Shoreline Distance (Miles)	Date Stocked	Number Stocked	Mark and *** Release Method	Stocking Size (Fish/lb)	Stocking Density (Fish/ Surface Acre)	Stocking Density (Fish/ Littoral Acre)	Stocking Density (Fish/ Shoreline Mile)
Johnson	7.4	40.3	18.5	1.089	8/13/81	1,995	LV (T)	458			
					8/13/81	1,930	RV (P)	458	196	428	7,268
					9/24/81	1,998	LV/AD (T)	205			
					9/24/81	1,992	RV/AD (P)	205			
Junction	13.2	10.9	6.0	0.588	8/12/81	540	LV (T)	438			
					8/12/81	543	RV (S)	422	199	362	3,692
					9/24/81	544	LV/AD (T)	205			
					9/24/81	544	RV/AD (S)	205			
Knik	9.1	50.4	23.7	1.477	8/13/81	5,070	(T)	485	201	428	6,860
					9/23/81	5,062	AD (T)	207			
Matanuska	9.4	61.5	14.1	1.619	8/11/81	3,070	LV (T)	514			
					8/11/81	3,060	RV (P)	455	200	871	7,588
					9/25/81	3,075	LV/AD (T)	207			
					9/25/81	3,080	RV/AD (P)	185			
Ravine	20.0	12.3	7.6	0.824	8/10/81	1,225	(T)	556			
					9/28/81	1,313	AD (T)	175	206	334	3,080
Reed	4.9	19.5	13.7	0.870	8/14/81	1,930	(T)	538	198	282	4,437
					9/28/81	1,930	AD (T)	175			
Sliver	22.9	7.2	5.1	0.571	8/11/81	490	LV (T)	454			
					8/11/81	489	RV (S)	471	272	384	3,429
					9/25/81	490	LV/AD (T)	191			
					9/25/81	489	RV/AD (S)	191			

Table 7. (cont'd) Stocking Summary for Swanson Strain Rainbow Trout in Selected Matanuska-Susitna Valley Lakes, 1981.

Lake*	MEI	Surface Area (Acres)	Littoral** Area (Acres)	Shoreline Distance (Miles)	Date Stocked	Number Stocked	Mark and *** Release Method	Stocking Size (Fish/lb)	Stocking Density (Fish/ Surface Acre)	Stocking Density (Fish/ Littoral Acre)	Stocking Density (Fish/ Shoreline Mile)
Tigger	2.7	18.9	10.8	0.862	8/14/81	2,295	(T)	538	243	425	5,328
					9/28/81	2,298	AD (T)	175			
Walby	...	40.0	...	...	8/13/81	4,000	(T)	485	200	...	...
					9/23/81	3,995	AD (T)	207			

* Junction, Knik, Matanuska, Tigger and Walby Lakes contain stickleback populations.

** Littoral area is that portion of the lake less than 15 ft deep.

*** Mark: LV = left ventral finclip; RV = right ventral finclip; AD = adipose finclip.
Release Method: P = held in pen for approximately 24 hours.
S = scatter plant; released around perimeter of lake.
T = stocked from hatchery truck at a single release site.

survival in various lake types. Sampling will be conducted in all nine lakes after breakup in the spring of 1982 and in the fall when the trout reach catchable size at Age I+.

Effect of Stocking Time on Fish Survival and Growth

To compare time of stocking on fish survival and growth three Matanuska-Susitna Valley lakes were each stocked with two groups of Swanson strain rainbow trout; i.e., left ventral clipped fingerling (LV) at approximately 435/lb stocked in August 1980 and right ventral clipped fingerling (RV) at approximately 520/lb stocked in September 1980 (Table 8). The three land-locked lakes chosen for this experiment included rehabilitated Kepler-Bradley Lake and Knik and Matanuska Lakes which have populations of three-spine stickleback. At the time of stocking each lake had a population of rainbow trout from prior years' plants.

Seasonal Sampling Procedures:

All lakes were sampled with minnow traps once a week from time of trout introduction until freeze-up in November then once a month through the ice until breakup near the end of April. During each sampling period up to 10 rainbow trout from each stocking group, LV and RV, were retained from each lake for length frequency measurements and gut analysis while the remaining trout were enumerated by fin mark and released. In Knik Lake and in Matanuska Lake 20 stickleback were kept each sample period for examination and the remainder of the catch was counted and released. From the end of April through the third week in June fish were collected with fyke nets and minnow traps. A final sample was taken in September by the use of fyke nets and gill nets.

Catch Comparisons

Minnow trap catches for the fall and winter sampling from October 1980 through April 1981 were dominated by the LV fingerling stocked in August. Fyke nets fished after breakup at the end of April showed similar results as again the fish stocked in August were more numerous. About June 1 in Kepler-Bradley Lake and June 15 in Knik and Matanuska Lakes, the September stocked RV trout equaled the catch of the LV fish (Figure 2). By the third week in June the catch rate for the RV marked fish surpassed that of the LV trout indicating the larger fish had moved into deeper waters from the shoal areas in each lake where the traps were being fished. Havens (1980) reported similar results relating to fish movement in Johnson Lake. Minnow traps, fyke nets and gill nets fished in early June captured rainbow trout fingerling, all less than 120 mm, only within waters less than 10 feet deep even though nets capable of catching these small fish had been set in waters as deep as 30 feet. The same gear set at the end of June indicated differential growth rates for the fingerling as minnow traps caught rainbow trout averaging 112 mm, all in water averaging less than 5 feet deep, fyke nets fished in water up to 10 feet deep caught fish with a mean length of 125 mm, while gill nets, fished at various depths throughout the lake, captured trout with a mean length of 154 mm.

The final sample taken in each lake in September 1981 with fyke nets and gill nets produced more fish with the RV mark indicating a relatively high

Table 8. Stocking Summary for Swanson Strain Rainbow Trout in Knik, Matanuska and Kepler-Bradley Lakes, 1980.

Lake	MEI	Stickleback Present	Surface Area (Acres)	Littoral* Area (Acres)	Shoreline Miles	Mark**	Date Stocked	Number Stocked	Stocking Size (Fish/lb)	Stocking Density (Fish/ Surface Acre)	Stocking Density (Fish/ Littoral Acre)	Stocking Density (Fish/ Shoreline Mile)
Knik	9.1	Yes	50.4	23.7	1.477	LV	8/11/80	4,985	486	197	419	6,723
						RV	9/16/80	4,945	521			
Matanuska	8.2	Yes	61.5	14.1	1.619	LV	8/12/80	6,042	419	196	854	7,435
						RV	9/15/80	5,995	534			
Kepler-Bradley	13.5	No	58.0	23.0	2.677	LV	8/12/80	5,825	419	200	553	4,336
						RV	9/16/80	5,783	505			

* Littoral area is that portion of the lake less than 15 feet deep.

** Mark: LV = left ventral finclip; RV = right ventral finclip.

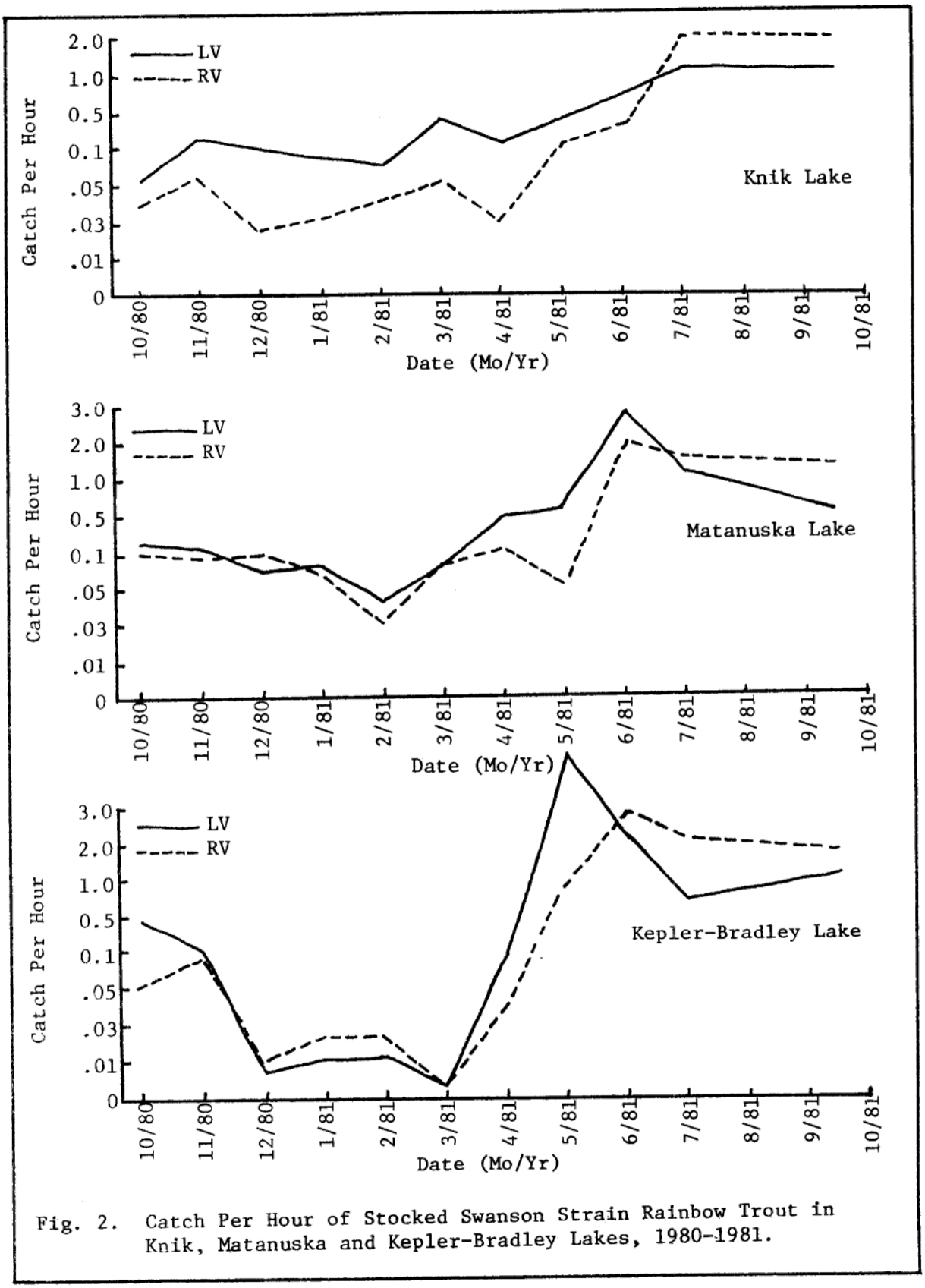

Fig. 2. Catch Per Hour of Stocked Swanson Strain Rainbow Trout in Knik, Matanuska and Kepler-Bradley Lakes, 1980-1981.

sport catch of the larger LV fish as was observed between June and September.

A comparison of overall catch rates by gear type for the 1980 plant of rainbow trout presented in Figure 3 shows catch per unit of effort was higher in Kepler-Bradley Lake than either of the stickleback infested lakes. Catch per unit of effort for rainbow trout was higher in Matanuska Lake than Knik Lake which in turn had a stickleback catch rate about three times that of Matanuska Lake (Figure 4). Although no rainbow trout were captured when open water areas of the three lakes were sampled in October and February, the ratio of rainbow trout to stickleback captured in shoreline sampling areas also indicates a greater population of stickleback in Knik Lake than in Matanuska Lake (Table 9).

Growth Comparisons

In addition to dissimilar catch rates the rainbow trout also demonstrated different growth features between stocking groups and between lakes. The 435/lb left ventral-clipped fingerling stocked in August, approximately one month before the 520/lb right ventral-clipped fingerling were introduced, entered winter at a larger size and maintained that size advantage for at least a year (Figures 5 and 6). Both groups of rainbow trout in Kepler-Bradley Lake grew larger than their counterparts in either Matanuska or Knik Lakes and the RV fish in Kepler-Bradley exceeded the mean size of the LV trout in Knik Lake by early May.

The preliminary results of a food habit study based on numerical occurrence of food items in stomachs from rainbow trout and stickleback in the three study lakes between September 1980 and June 1981 are presented in Table 10. It appears noteworthy that the trout in Kepler/Bradley Lake fed heavily on zooplankton during all seasons whereas the trout fingerling in the two lakes containing stickleback displayed a more varied food selection. The importance of zooplankton in the diet of stocked trout is not clearly understood, however, it seems likely that the availability of this food source may be an important factor in trout survival and growth. Table 11 shows that stickleback in Matanuska Lake, mean length of 44-48 mm, consumed zooplankton as their major food item fall through spring while the Knik Lake stickleback, mean length 57-62 mm, switched from zooplankton to midge larva in the spring after ice-out. A more detailed analysis of the food habits of rainbow trout planted in Knik, Matanuska and Kepler-Bradley Lakes in 1980 will appear under separate cover (Wenderoff, in prep.).

Discussion:

Better growth and relative survival in Kepler-Bradley Lake follow a pattern found for other studies in the Matanuska-Susitna Valley comparing rehabilitated lakes to those lakes containing stickleback (Chlupach, 1978; Havens, 1980). Stickleback may have reduced the populations of zooplankton and smaller benthic invertebrates in Knik and Matanuska Lakes while rainbow fingerling introduced into Kepler-Bradley Lake were able to acquire preferred food without inter-species competition.

Lower survivals of stocked RV trout may have been the result of several factors. Studies by Havens (1979, 1981) indicate the greatest loss of

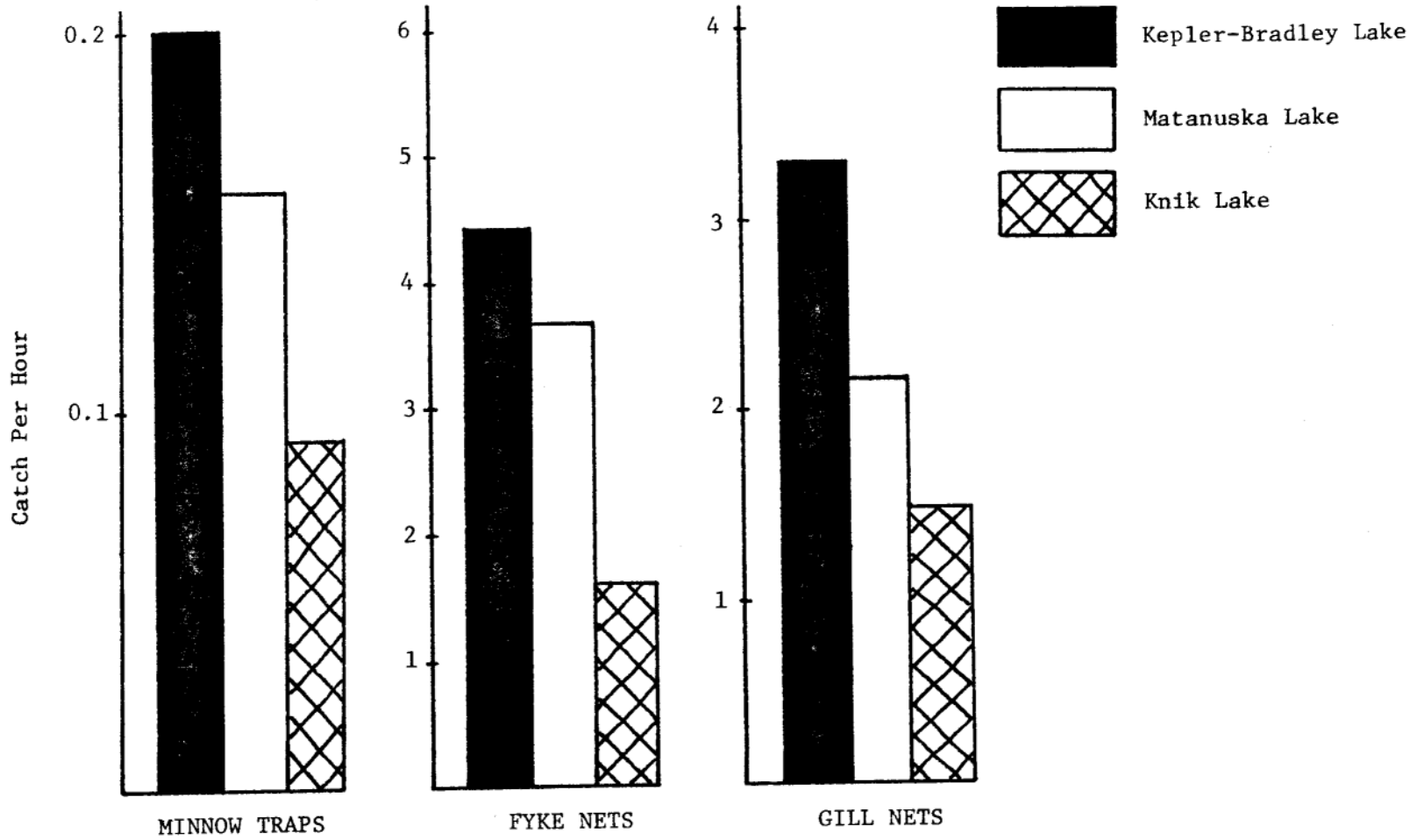

Fig. 3. Combined Catch Per Hour by Gear for 1980 Stocked Swanson Strain Rainbow Trout in Kepler-Bradley, Matanuska and Knik Lakes, 9/18/80 - 9/17/81.

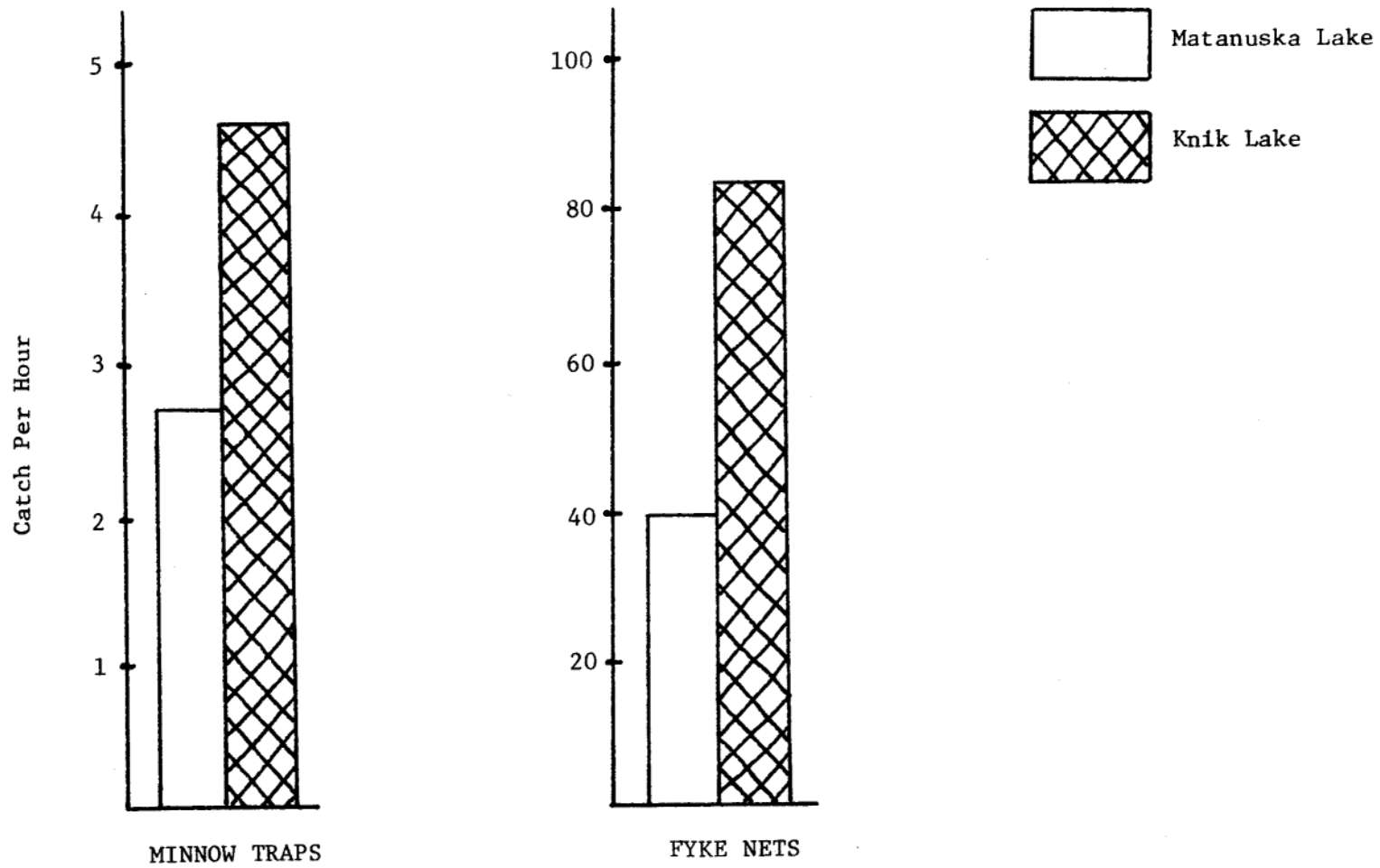

Fig. 4. Catch Per Hour for Threespine Stickleback by Gear in Matanuska and Knik Lakes, 8/22/80 - 6/25/81.

Table 9. Catch Ratio of Rainbow Trout to Stickleback in Shoreline Areas of Knik and Matanuska Lakes, 1980 - 1981.

Lake	Fall (August - October) MT* RT : TS**	Winter Ice Cover (December - April) MT* RT : TS**	Spring (May - June) MT* RT : TS**	Spring (May - June) FN* RT : TS**	Total (August - June) MT & FN* RT : TS**
Knik	1 : 85 (883 : 28,870)	1 : 5 (324 : 1,690)	1 : 165 (92 : 15,160)	1 : 49 (402 : 19,750)	1 : 56 (1,174 : 65,470)
Matanuska	1 : 7 (481 : 3,515)	1 : 6 (329 : 2,050)	1 : 132 (88 : 11,655)	1 : 5 (972 : 5,005)	1 : 12 (1,870 : 22,225)

* MT = minnow traps; FN = fyke nets.

** RT = rainbow trout stocked in August and September 1980; TS = threespine stickleback.

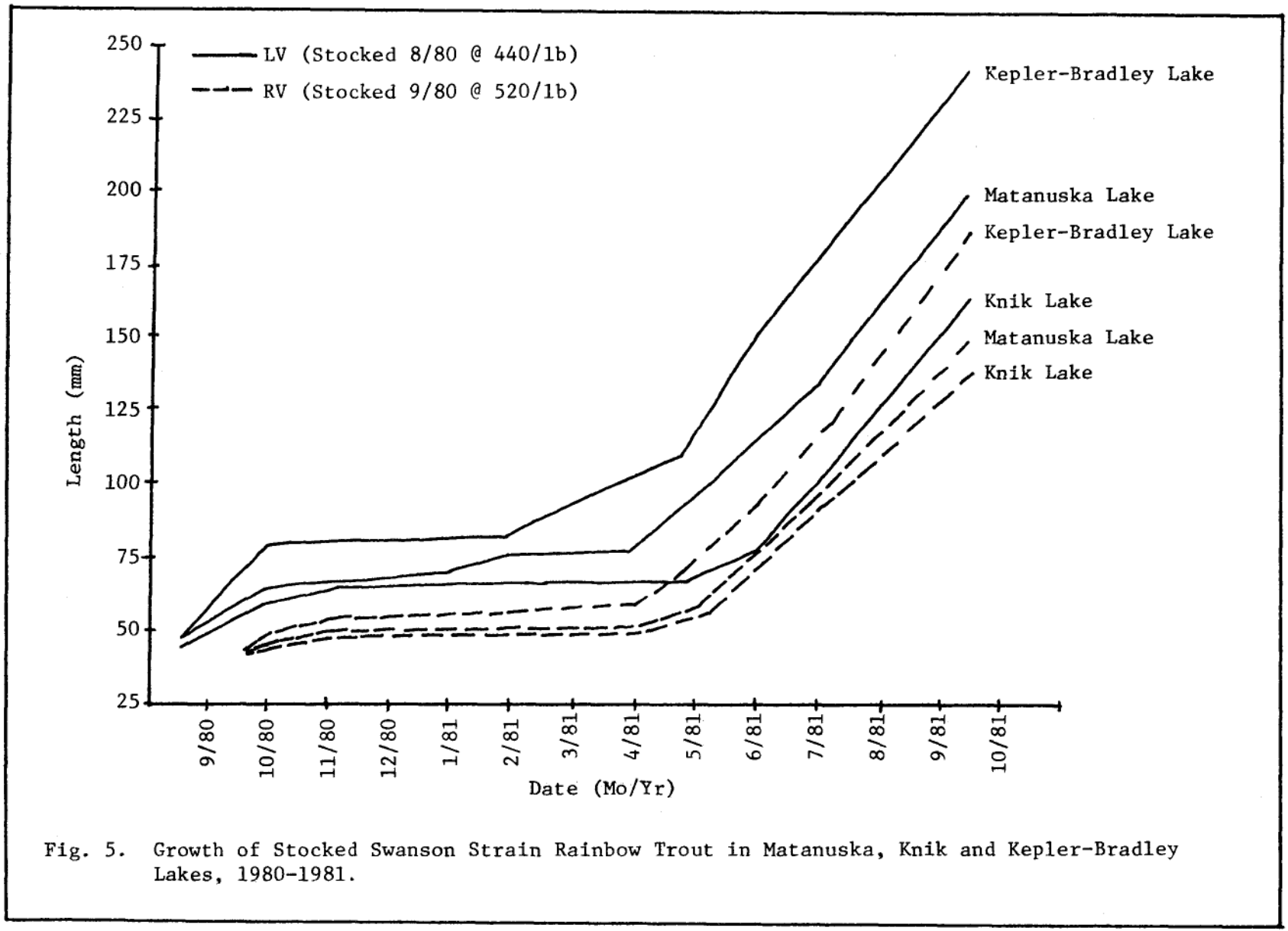

Fig. 5. Growth of Stocked Swanson Strain Rainbow Trout in Matanuska, Knik and Kepler-Bradley Lakes, 1980-1981.

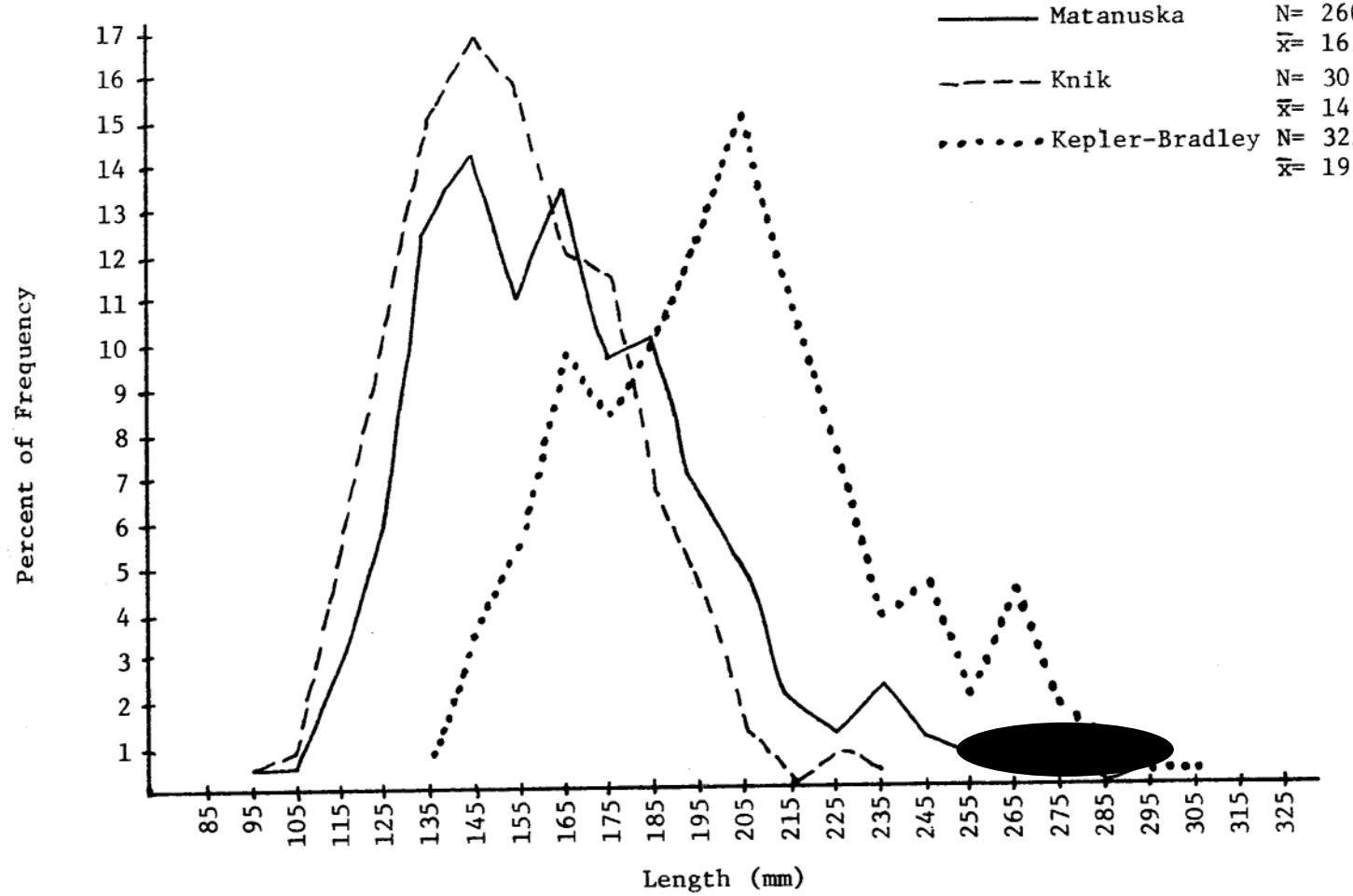

Fig. 6. Length Frequency by Percent for Age I+ Swanson Strain Rainbow Trout Caught by Sample Nets in Matanuska, Knik and Kepler-Bradley Lakes, 1981.

Table 10. A Comparison of Stomach Content Composition by Numerical Percentage for Fish Captured in Knik, Matanuska and Kepler-Bradley Lakes, 1980 - 1981.

Lake	Species* (mark)	Stomach Contents*** Fall #**	I	B	Z	Stomach Contents*** Winter #**	I	B	Z	Stomach Contents*** Spring #**	I	B	Z	Stomach Contents*** Total #**	I	B	Z
Knik	RT (LV)	56	59%	38%	3%	24		12%	88%	38	5%	95%		118	22%	49%	29%
	RT (RV)	24	10%	28%	62%	14			100%	28	11%	89%		66	7%	39%	54%
	TS	159		20%	80%	60		21%	79%	80	1%	79%	20%	299	1%	39%	60%
Matanuska	RT (LV)	81	69%	29%	2%	40		51%	49%	47	4%	96%		168	24%	59%	17%
	RT (RV)	41	35%	62%	3%	26		46%	54%	40	4%	96%		107	13%	68%	19%
	TS	101	11%	30%	59%	67		15%	85%	80	2%	20%	78%	248	5%	21%	74%
Kepler-Bradley	RT (LV)	49	3%	4%	93%	23	5%	3%	95%	46	3%	41%	56%	118	2%	16%	82%
	RT (RV)	34	7%	15%	78%	23	16%	2%	84%	42	2%	36%	62%	99	3%	22%	75%

* Rainbow trout stocked in each lake in August 1980 were marked with a left ventral clip (LV) while those stocked in September 1980 were marked with a right ventral clip (RV). TS = threespine stickleback.

** Number given is the total number of stomachs that contained food.

*** Stomach contents (numerical percentages): I = adult winged insects including water striders; B = Benthic organisms including worms, snails, clams, leeches, hydra, larval insects and adult water beetles and water boatmen; Z = zooplankton including waterfleas and copepods.

Table 11. A Comparison of Length Frequency and Major Food Items by Seasonal Period for Rainbow Trout and Stickleback in Knik, Matanuska and Kepler-Bradley Lakes, 1980 - 1981.

		Fall (August-October)		Winter Ice Cover (December-April)		Spring (May-June)	
Lake	Species* (Mark)	Mean** Length Range	Major*** Food Items	Mean** Length Range	Major*** Food Items	Mean** Length Range	Major*** Food Items
Knik	RT (LV)	46-67mm	deerflies	65-71mm	copepod eggs & waterfleas	61-106mm	caddisfly larva
	RT (RV)	47-51mm	waterfleas	53-56mm	waterfleas & copepods	51-81mm	caddisfly larva
	TS	58mm	waterfleas	57mm	waterfleas	62mm	midge larva
Matanuska	RT (LV)	51-73	deerflies	68-83mm	waterfleas & gammarus	86-148mm	caddisfly larva & damselfly nymph
	RT (RV)	48-55mm	caddisfly larva	52-56mm	gammarus & waterfleas	58-100mm	caddisfly larva
	TS	44mm	waterfleas	44mm	copepods	48mm	waterfleas & copepods
Kepler-Bradley	RT (LV)	57-89mm	waterfleas	78-104mm	waterfleas	106-165mm	waterfleas & damselfly nymph
	RT (RV)	50-57mm	waterfleas	54-63mm	waterfleas	68-118mm	waterfleas & mosquito larva

* Rainbow trout stocked in each lake in August 1980 were marked with a left ventral clip (LV) while those stocked in September 1980 were marked with a right ventral clip (RV). TS = threespine stickleback.

** Mean length range is the actual increase in mean length for rainbow trout during a seasonal period. The mean length for threespine stickleback during each seasonal period remained about the same.

*** Major food items: derived by counting numbers of organisms in gut samples taken throughout each seasonal period.

newly planted rainbow trout fingerling may occur during the first few days or weeks after introduction. The larger (435/lb) LV marked fingerling were stocked in August at a density of approximately 100 fish per surface acre and some immediate predation mortality could be expected by large holdover trout from previous plants as well as possible loss from disease, deformities and the marking and transport process from the hatchery. At the time the smaller (520/lb) RV fish were stocked in September at 100 fish per surface acre they would experience the same pressures as the LV trout and would presumably face competition for food and habitat from the surviving larger LV fish. Another possible contributing factor for the better LV survival is that August may be a more favorable seasonal period for rainbow trout fingerling to be introduced into Matanuska-Susitna Valley lakes.

Comparison of Rainbow Trout Overwinter Survival and Growth

Havens (1981) reported results of an investigation to evaluate fish liberation methods in two Matanuska-Susitna Valley lakes. Johnson Lake, a rehabilitated lake containing a large population of Age I+ and Age II+ stocked rainbow trout and Long Lake, containing a stickleback population but very few remnant stocked trout, were each stocked at about equal densities with three marked groups of Swanson strain rainbow trout fingerling in August 1980 (Table 12). Population estimates in October, 7 weeks following trout introduction, revealed slight differences in survival for each release method but a substantial dissimilarity between overall trout survival of 29% in Johnson Lake and 53% in Long Lake (Table 13).

At the time of stocking in August, the rainbow trout fingerling planted in both lakes had an average length of about 44 mm. By the time of the population estimates 7 weeks later, the fingerling in Johnson Lake had increased in size to average 80 mm in length with a range of 62-102 mm while those in Long Lake were only 64 mm with a length range of 48-85 mm (Havens, 1981).

Population estimates performed in Johnson and Long Lakes in May 1981 after ice-out indicated there was no loss of the 1980 stocked rainbow trout fingerling over the winter ice-cover period in Johnson Lake but a significant loss of fish in Long Lake. Johnson Lake had a point estimate of 2,325 trout in October 1980 and an estimate of 2,406 in May 1981 while the point estimate for Long Lake trout in October was 7,226 but the following May it was only 4,628 (Table 13).

Rainbow trout captured in Johnson Lake on May 12, 1981 averaged 112 mm in length with a range of 84-147 mm while 2 weeks later in Long Lake the mean length for trout was 86 mm with a length range of 55-152 mm. By the fall following stocking Johnson Lake trout at Age I+ averaged 307 mm (12 in) in length while those in Long Lake were only 182 mm (7 in) in length (Table 14).

Discussion:

The population estimates performed in Johnson and Long Lakes in October 1980 and May 1981 indicated a significant loss of rainbow trout fingerling within a few weeks following introduction and for stickleback-infested Long Lake an additional loss of fish between fall and spring. The greater

Table 12. Swanson Strain Rainbow Trout Stocking Summary for Johnson and Long Lakes, 1981-1982.

Lake	MEI	Surface Area (Acres)	Littoral* Area (Acres)	Shoreline Miles	Number Stocked	Stocking Size (Fish/lb)	Mark**	Release*** Method	Stocking Density: Fish/ Date Stocked	Stocking Density: Fish/ Surface Acre	Stocking Density: Fish/ Littoral Acre	Stocking Density: Shoreline Mile
Johnson	7.4	40.3	18.5	1.089	2,650	424	AD	P	8/13/80			
					2,685	473	LV	S	8/15/80	199	434	7,378
					2,700	447	RV	T	8/15/80			
Long	9.4	74.4	20.8	2.367	4,963	451	AD	P	8/15/80			
					3,750	472	LV	S	8/18/80	182	651	5,717
					5,000	472	RV	T	8/18/80			

* Littoral area is that portion of the lake less than 15 ft deep.

** Mark: AD = adipose finclip; LV = left ventral finclip; RV = right ventral finclip.

*** Release method:

P = held in pen and fed; most fish escaped after 15-30 hours.

S = scatter plant; released around perimeter of lake.

T = stocked from hatchery truck at a single release site.

Table 13. Population Estimates for Stocked Swanson Strain Rainbow Trout in Johnson and Long Lakes, 1980 and 1981.

Lake	Mark and* Release Method	Date Stocked	Number Stocked	Date of Estimate	Population Estimate	Survival	95% Confidence Level Estimate	95% Confidence Level Survival
Johnson	AD (P)	8/13/80	2,650	10/7/80	865	33%	805-924	30%-35%
	LV (S)	8/15/80	2,685	10/7/80	685	26%	629-741	23%-28%
	RV (T)	8/15/80	2,700	10/7/80	776	29%	718-834	27%-31%
	TOTAL		8,035		2,326	29%	2,059-2,623	26%-33%
	AD (P)	8/13/80	2,650	5/12/81	892	34%	821-964	31%-36%
	LV (S)	8/15/80	2,685	5/12/81	735	27%	667-804	25%-30%
	RV (T)	8/15/80	2,700	5/12/81	778	29%	709-847	26%-31%
	TOTAL		8,035		2,405	30%	1,784-3,234	22%-40%
Long	AD (P)	8/15/80	4,963	10/9/80	2,739	55%	2,600-2,878	52%-58%
	LV (S)	8/18/80	3,570	10/9/80	2,041	57%	1,913-2,170	54%-61%
	RV (T)	8/18/80	5,000	10/9/80	2,445	49%	2,309-2,581	46%-52%
	TOTAL		13,533		7,226	53%	6,406-8,212	47%-61%
	AD (P)	8/15/80	4,963	5/27/81	2,084	42%	1,946-2,223	39%-45%
	LV (S)	8/18/80	3,570	5/27/81	1,302	36%	1,177-1,428	33%-40%
	RV (T)	8/18/80	5,000	5/27/81	1,241	25%	1,118-1,365	22%-27%
	TOTAL		13,533		4,628	34%	3,593-5,936	27%-44%

* Mark: AD = adipose finclip; LV = left ventral finclip; RV = right ventral finclip.
Release Method: P = held in pen and fed; most fish escaped after 15-30 hours.
S = scatter plant; released around perimeter of lake.
T = stocked from hatchery truck at single release site.

Table 14. Length - Weight Summaries for Swanson Strain Rainbow Trout in Johnson and Long Lakes, 1980 and 1981.

Lake*	MEI	Mark**	Date Stocked	Number Stocked	Stocking Size (Fish/lb)	Capture Date	Number Captured	Mean Length (mm)	Length Range (mm)	Mean Weight (g)	Weight Range (g)	C.F.***
Johnson	7.4	Ad	8/13/80	2,650	424		203	82	69-102	...	...	...
		LV	8/15/80	2,685	473	10/7/80	172	79	63-99	...	...	...
		RV	8/15/80	2,700	447		168	80	63-102	...	...	...
		AD	8/13/80	2,650	424		41	112	85-145	...	...	...
		LV	8/15/80	2,685	473	5/12/81	34	110	84-131	...	...	...
		RV	8/15/80	2,700	447		36	113	92-147	...	...	...
		AD	8/13/80	2,650	424		29	143	114-179	...	...	...
		LV	8/15/80	2,685	473	6/ 2/81	32	138	103-168	...	...	...
		RV	8/15/80	2,700	447		39	141	101-165	...	...	...
		AD	8/13/80	2,650	424		12	306	276-340	347	244-454	1.21
		LV	8/15/80	2,685	473	10/21/81	9	305	242-335	332	168-456	1.17
		RV	8/15/80	2,700	447		7	312	266-342	356	216-504	1.17
Long	9.4	AD	8/15/80	4,963	451		133	65	48-88	...	...	...
		LV	8/18/80	3,750	472	10/7/80	100	64	48-82	...	...	...
		RV	8/18/80	5,000	472		145	62	49-85	...	...	...
		AD	8/15/80	4,963	451		159	88	55-152	...	...	...
		LV	8/18/80	3,750	472	5/27/81	124	87	61-122	...	...	...
		RV	8/18/80	5,000	472		132	81	58-136	...	...	...
		AD	8/15/80	4,963	451		94	184	132-367	85	20-640	1.36
		LV	8/18/80	3,750	472	10/22/81	59	182	132-308	79	20-384	1.31
		RV	8/18/80	5,000	472		80	180	130-325	73	20-386	1.25

* Long Lake contains a population of stickleback.

** Mark: AD = adipose finclip; LV = left ventral finclip; RV = right ventral finclip.

*** C.F. = Condition Factor = $\frac{100,000\ W}{L^3}$

initial loss of newly stocked fingerling in Johnson Lake may have been due to predation by the approximately 2,000 large trout (about 50 fish per surface acre) while in Long Lake predation by the very few large holdover trout would have been minimal. Although Johnson and Long Lakes have similar relative fertilities, MEI 7.4 and MEI 9.4 respectively, the slower initial growth, the subsequent overwinter loss of fish and the smaller size attained by Age I+ trout in Long Lake was probably influenced by the presence of stickleback as was discussed in the previous section regarding the growth and relative survival of rainbow trout in Knik, Matanuska and KeplerBradley Lakes.

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